DOCUMENT RESUME

ED 344 017 CE 060 743

AUTHOR Kooker, Steve; Brey, Ron
TITLE Development Report for the Telecommunications Technology 2+2 Program. Grant Year 2--1990/1991.
INSTITUTION Austin Community Coll., Tex.
SPONS AGENCY Texas Higher Education Coordinating Board, Austin. Community Colleges and Technical Institutes Div.
PUB DATE 91
NOTE 62p.
PUB TYPE Reports - Descriptive (141)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Articulation (Education); College School Cooperation; Competency Based Education; Computer Networks; *Curriculum Development; *Electronics; *Electronic Technicians; High Schools; Needs Assessment; School Business Relationship; Student Recruitment; *Telecommunications; Two Year Colleges; Vocational Followup
IDENTIFIERS 2 Plus 2 Tech Prep Associate Degrees; Austin Community College TX

ABSTRACT

This report describes the second-year activities of Austin (Texas) Community College's development of a curriculum for a degree in Telecommunications Technology (Electronics) involving an articulation agreement with Leander Independent School District. Specifically, the report describes: the planning of five credit courses for telecommunications specializations and the approval process (detailed in meeting minutes); the project's ongoing contacts with industry; instructor preparation; collection of resources; student recruitment; liaison with Leander High School; development of a "how-to" manual for telecom 2+2 programs; activities of course graduates; and development of a graduation follow-up assessment process. Four appendices form half of the document; they contain: a listing of principal investigators; detailed outlines for the five courses--introduction to telecommunications, telecommunications technologies I, telecommunications networks, telecommunications technologies II, and telecommunications internship; support course evaluation report; and description of the course assessment process. (NLA)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

#11110005

ED344017

DEVELOPMENT REPORT FOR THE TELECOMMUNICATIONS TECHNOLOGY 2+2 PROGRAM

Grant Year 2 - 1990/1991

Submitted by the

ELECTRONICS DEPARTMENT
of the
TECHNOLOGY/GRAPHICS DIVISION

Prepared by

Steve Kooker
Instructor of Telecommunications Technology

Ron Brey
Project Administrator

AUSTIN COMMUNITY COLLEGE
P.O.Box 140646
Austin, Texas 78714

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

BEST COPY AVAILABLE

CE060743

FOREWARD

As the United States enters the 1990's decade, certain technical areas of our society are growing at a disproportionate rate relative to other areas. To best serve the community, including both industry and its future workers, educational institutions must aggressively pursue curriculum in the expanding areas. An area which is particularly in need of attention is one which is broadly identified as "telecommunications".

Recognizing this need, Austin Community College submitted an application to the Texas Higher Education Coordinating Board in 1989 for a Carl Perkins Act grant for the development of the curriculum for a Telecommunications Technology degree at Austin Community College. A companion grant from the Texas Education Agency to the Leander Independent School District made possible the structuring of a 2+2 articulation agreement.

This report describes the activities of the second grant year, 1990/1991, including the progress of curriculum development and the first course offerings. A report for the preceding year is also available from ACC, and describes the earlier stages of the telecommunications program development.

EXECUTIVE SUMMARY

This report describes a developmental process having as its objective the development of a curriculum for an Associate Degree in Electronics Technology with specialization in Telecommunications.

Described here are the activities and results of the second year of the five-year planned process of curriculum development and evaluation.

This second year of the program found us moving from the course general descriptions to more detailed course outlines. ACC also offered the first course in the series, "Introduction to Telecommunications", with good success. The last four courses of our planned five-course curriculum in telecommunications were approved by the Texas Higher Education Coordinating Board.

During the next two years, ACC expects to offer the four other courses in our curriculum plan. Development of lab facilities and instructional capability will continue, and development of the 2+2 articulation agreements with high schools and four year colleges will receive additional attention.

The second year also saw the development of a detailed evaluation process. It will measure how well students are being trained, their employment upon leaving ACC, and provide information for periodic evaluation of courses and the program.

TABLE OF CONTENTS

SECTION TITLE	
EXECUTIVE SUMMARY	
INTRODUCTION	1
PROCESS OVERVIEW	3
DETAILED PLANNING FOR TELECOMMUNICATIONS COURSES	4
A DESCRIPTION OF THE COURSE APPROVAL CYCLE	6
ONGOING INDUSTRY LIAISON	12
INSTRUCTOR PREPARATION	17
RESOURCE COLLECTION	18
STUDENT RECRUITMENT	19
DESCRIPTION OF INITIAL COURSE OFFERINGS	20
EVALUATION OF ELECTRONICS TECHNOLOGY SUPPORT COURSES	21
LIAISON WITH THE HIGH SCHOOL LEVEL	22
DEVELOPMENT OF A HOW-TO MANUAL FOR TELECOM 2+2 PROGRAMS	23
ACTIVITIES OF COURSE GRADUATES	24
DEVELOPMENT OF A GRADUATION FOLLOW-UP ASSESSMENT PROCESS	25
APPENDIX A - LISTING OF PRINCIPAL INVESTIGATORS	
APPENDIX B - DETAILED COURSE OUTLINES	
APPENDIX C - SUPPORT COURSE EVALUATION REPORT	
APPENDIX D - ASSESSMENT PROCESS DESCRIPTION	

INTRODUCTION

Telecommunications may be broadly defined as the process by which information gets transferred electronically from one place to another.

Examples of telecommunications in our society include the basic telephone system which most of us have always taken for granted, modern cellular and mobile telephones, the interconnection of our society's computers into vast networks such as the credit card verification network, facsimile transmission, broadcast and cable television/radio, and many others.

The decreasing cost of electronics equipment makes the extensive use of telecommunications techniques financially attractive to our industries; speed and accuracy of transactions conducted using telecommunications is necessary for these industries to be competitive. In many instances, whole new modes of communications are now possible because of recent electronic telecommunications inventions. Market forces are combining to create a very fast-growing installed base of telecommunications equipment , not just in traditional "telephone company" environments, but in almost all companies.

The electronics technology graduate from the current program at Austin Community College has many of the skills necessary to work on the equipment found in the telecommunications industry. On the other hand, there are a number of specialized areas within the telecommunications discipline which are not presently taught, because of a lack of time within the program. Historically, graduates who entered the telecommunications field supplemented their college background by on-the-job training in this special area. This arrangement was quite satisfactory when telecommunications was primarily the domain of a few large telephone companies, which wished to provide their own internal (proprietary) coursework for new technicians. In the wake of telephone industry divestiture and the arrival of many new telecommunications-technology inventions, the industries now hiring our students are more typically small companies with no internal training programs, using a diverse collection of telecommunications technologies and equipment. These smaller, growing companies need a graduate who has spent enough class time on telecommunications topics to be an immediate, self-starting, contributor in the field.

Emergence of a cooperative program involving Austin Community College and local high schools, known as a 2+2 or Tech Prep Articulation Agreement, offers a solution to the problem of how course time at the college level can be found to address special areas such as telecommunications. For example, students in the Leander Independent School District can take basic electronics

courses at Leander High School which are equivalent to courses at ACC. This allows students to take more advanced courses in telecommunications while at ACC for two years.

Given the opportunity provided by the 2+2 Articulation Agreement, and the need of industry for telecommunications technology specialists, Austin Community College has begun developing the specialized coursework which will prepare its graduates for the field.

PROCESS OVERVIEW

A preceding report described in detail the activities of the first grant year, 1989/1990. In brief, those activities were primarily fact-finding exercises designed to determine the competencies needed by a graduate to function as a specialist in the telecommunications field. Surveys of other colleges having telecommunications curricula, surveys of local industries which employ telecommunications personnel, a formal DACUM process, site visits at other colleges and at local industries, and the organization of a Telecommunications Steering Committee all contributed to our information base for generation of a formal curriculum plan.

As we entered the second year of our curriculum development process, the focus shifted to detailed course plan preparation. During the year, plans for all of the courses were completed. Approvals for the courses were then sought, first from the ACC Curriculum Committee and Board of Trustees and then from the Texas Higher Education Coordinating Board. All the courses received approval.

Since the first course in the series was effectively the same as a course previously approved at ACC but never before offered, we were able to offer it for the first time during the spring 1991 semester, and for a second time during the summer 1991 semester.

Resource requirements for the courses were defined for school administration during this second year, as the courses took on a more detailed identity.

Promotion and recruiting by the Instructor/Coordinator resulted in good exposure for the program in the local newspaper and through local industries involved in the Steering Committee and the local telecommunications industry association.

A report which evaluated the present course content of the Electronics Technology program at ACC with respect to its suitability for preparing students for the Telecommunications Specialization was generated.

Another report designed to assist other colleges in the development of similar Telecommunications Technology programs was prepared.

Involvement of some local industries resulted in donations of equipment and other resources such as video tape training materials.

DETAILED PLANNING FOR TELECOMMUNICATIONS COURSES

As the Grant Year 1990-1991 began, the information gathered during the previous year about student competencies was ready to be organized into individual specific courses.

A total of five credit courses emerged. The first course was relatively easy to define: an introduction to the field of telecommunications which could be used by a large number of students as an advanced elective in the field, and by a smaller number of students for whom the follow-up courses would make them a telecommunications specialist. Such a course had been identified prior to the Telecommunications 2+2 Grant program and was already listed in the Electronics Technology curriculum as an advanced elective, ELN2274. This proved to be very advantageous to the grant program, since we were able to offer this course for two semesters prior to approval of the other courses.

The remaining four courses of the five-course series were developed by observing that telecommunications competencies for technicians in industry tend to cluster around three principal centers.

One specialization within the telecom field is involved with connecting things together in networks, including common-carrier telephone networks and local area networks. Thus, one course should explore networking in detail. This course is identified as ELN2294.

A second specialization is an involvement with very technical circuit-level equipment performance, particularly in the analog or linear areas. This calls for a course which deals with such detailed circuit performance in cases where telecom equipment uses technology more advanced than is covered in previous courses in the Electronics Technology curriculum. This course is identified as ELN2284.

A third specializaton is aimed at the graduate who wishes to work in the moré traditional telecommunications job, where the tasks involve installation and maintenance of common-carrier equipment. This will require training in specific tools, test equipment, and procedures of the industry. ACC's course will be ELN2324.

The final course to be offered will be an internship in local industry, to provide both an opportunity for the student to learn practical things, as well as an opportunity for industry to evaluate the student for possible employment. The ACC course number is ELN2334.

Appendix B of this report contains the detailed course outlines

which were developed as a result of the considerations described in this section.

A DESCRIPTION OF THE COURSE APPROVAL CYCLE

Once the course outlines were completed in their initial form, they were presented to the Telecommunications Steering Committee, Electronics Technology Advisory Board, and the ACC Curriculum Committee.

At each level of examination and approval, opportunity was given to the approving bodies to make changes. Several small changes were made at the first two levels.

Minutes of the meetings involved are found on the following five pages of this report.

Once approval at the committee level was obtained, the course descriptions were forwarded to ACC's Board and to the State Coordinating Board, where they were approved during this grant year.

MINUTES
of the Telecommunications 2+2 Steering Committee Meeting
Friday, November 16, 1990, 7:45 AM

This meeting of the Steering Committee kicked off 1990/1991 activity for the group. Members present were Dell Dobbs (Southwestern Bell), Charles Ford (MCI), Rusty Campbell (TI), Robert Marion (State of Texas), Karen Kalergis (Capitol Area Telecom Association), Steve Kooker, Ron Brey, and Bert Marcom (Austin Community College), Ron Winkelman (TEA), Maggie Rice, Art Ruppert, David Jones, Charley Rouse, Hubert Dixon, and Liz Parker (LISD).

The group was welcomed by Steve Kooker, the Telecommunications Instructor/Coordinator for ACC, and each member present was introduced.

A brief statement of purpose for the meeting followed.

Ron Brey, the 2+2 Project Director, reviewed the activities of the past year and the goals for 1990/1991, which are also described in the formal reports distributed to the members prior to the meeting. Ron also discussed some of the growth of the 2+2 program at ACC, with the hoped-for addition of Bastrop High School and Del Valle High School.

Maggie Rice, Director of Curriculum and Instruction for the Leander Independent School District, introduced Art Ruppert, the new instructor for Electronics and the "Introduction to Telecommunications" course at Leander High School. Also introduced was the new instructor for Principles of Technology at LHS, Mr. David Jones. A course description for the Leander High School "Introduction to Telecommunications" course was presented; this will be offered for the first time in the Spring, 1991 semester.

Steve Kooker made a brief presentation which described the five courses currently contemplated for Austin Community College's telecommunications specialization within its Electronics Associate Degree Program. These were presented in "strawman" outline form for consideration and comment by the industry members present. Following Steve's presentation, the floor was opened for comment, with suggestions for comment provided in the agenda for the meeting.

Rusty Campbell of Texas Instruments suggested that the courses might accentuate the software, protocols, and standards of the telecom industry a little more. He sees an emphasis in the current course outlines on the hardware of telecommunications. This is necessary but not sufficient for his technicians. For example, during the process of troubleshooting a Local Area Network, they must think not only in hardware terms,

but must also comprehend the entire multi-level system structure. Terms such as TCP/IP should be familiar to the technician.

Dell Dobbs of Southwestern Bell suggested that the courses include exercises in customer-contact skills, such as tact. A prevalent problem in the industry today is that technicians are generally very technically competent but have limited interpersonal skills. This causes needless problems and delays during equipment outages, when they let personal bias and conflicts interfere with group-oriented problem solving. Dell suggested that lab exercises include activities to build interpersonal skills and group problem solving. He also suggested that the video tape entitled "Negotiating Skills", by Roger Dawson, might be appropriate for technician candidates. Students need to practice listening skills, so that they solve the customer's problem. They should finish listening to the customer's description of the problem before they charge off to fix something based on the first thing they hear. Dell suggested that instructions for laboratories be given verbally rather than in writing, and that grades reflect the student's listening performance, among other things.

Ron Brey suggested that each course outline be modified to describe specifically how it will provide training in writing, speech, and customer relations.

Charles Ford pointed out that each course should be taught with an emphasis on re-applicable knowledge. Principles are the important thing, as is the ability to retrain oneself on new equipment as it comes onto the scene. Students should comprehend the basic standards of the telecommunications industry. For industry, a very expensive problem is the necessity to send technicians back to school on every new system. An attractive alternative is to train technicians so well in basic theory and standards that they are able to retrain themselves in most instances. This would cut down on absences from the workplace for training purposes, and the management problems which result from such absences.

Ron Winkelman of the Texas Education Agency commented that his Agency is increasingly aware of a need to integrate technical vocational training with educational basics such as reading, writing, presentations skills, interpersonal skills, etc.. Efforts are underway at the state regulatory level to accomplish integration.

Robert Marion of the Texas State Capitol Telecommunications Service Division commented that he thought the course outlines presented promised to produce the kind of technician he currently seeks (somewhat unsuccessfully) in the local job market. He has recently hired older personnel who are close to retirement, because he cannot find younger technicians capable of the work he has to do. He looks forward to seeing some graduates from

this program in the near future. Six new jobs in the next five years are projected for his group alone. Military training has not proven to be useful in his situation, because the military equipment emphasizes mobile telephone systems which are different in manufacture and standards from commercial telephone equipment.

Steve Kooker summarized the findings of this meeting. With some adjustments in certain areas as discussed above, the industry participants were satisfied and pleased with the courses as presented. The next step at the ACC level will be approval by the Advisory Board of the Electronics Department, followed by approval by the ACC Curriculum Committee. The courses will then be submitted for approval by the Texas Higher Education Coordinating Board. One course has previously been approved in this manner (Introduction to Telecommunications) and will be taught for the first time during the Spring, 1991 Semester.

A discussion of equipment needs concluded the meeting. Industry participants will look for opportunities to contribute in this area. ACC will provide a list of needed equipment for the various course levels before the end of 1990.

The meeting was adjourned.

Minutes
Electronics Advisory Committee
February 7, 1991

The Electronics Advisory Committee of Austin Community College met on February 7, 1991 at 7:00 PM at the Nighthawk Restaurant.

Members present were: Allen Boger, Nick Broline, Tom Myers, Del Dobbs, John Garcia and Art Ruppert.

An update of events and changes in and affecting the Electronics department since our last meeting was presented by Bob Bixler, Department Head for Electronics at ACC.

Bob announced that a move was imminent, a call was received by our Department to have us poll our Advisory committee for a move -now it looks like we are going to move to the Pinnacle in Oak Hill. We have two concerns: 1) The move South would affect the student population and 2) with two moves in a year and half, our equipment would be at a risk.

There was a discussion on building a lab at the Pinnacle and one at Northridge. Kurt Nalty suggested perhaps that we could keep both labs the Pinnacle (south) and Northridge (north). Bob asked for an opinion of the committee. The committee thought the moves were a disadvantage both to staff and students.

The Microcontroller course was discussed with Kurt Nalty giving a brief explanation of the course. Three options were discussed 1) Add another elective; 2) Drop MP III and replace it with Microcontroller course and 3) Generalize MP III as we have it now and the following semester as a specialization. This means a student could take either one for credit but not both for credit toward a degree. Norm Colbath suggested it could be done as a Special Problems course, 3 hour course and 1 hour lab. Del Dobbs asked what prompted the Microcontroller course; it resulted from discussions among faculty and the fact that it represents a new area in the market.

Allen Boger moved that the Microcontroller course be scheduled as a Special Problems course; Del Dobbs seconded the motion, the motion carried.

Our enrollment is down slightly. It is low in the lower level courses. Among the reasons are 1) the TASP mandated testing for new incoming students, 2) suspected poor counseling (we have asked that all students in the Electronics field be sent to us) and 3) the Gulf crisis.

After some discussion it was decided that the Project Fabrication (PC Lab) be reduced during the duration of the move to the Pinnacle. Outside facilities could be used for board making. Tom Myers suggested we find someone in Austin to do it for us - if not expensive - he did not think it wise to do without the PC lab. Allen Boger suggested that we discontinue the PC Lab for the period of one year and bring back to the committee to decide further in six months.

Steve Kooker presented a proposal to establish four new elective courses in the area of telecommunications. The content of these courses has been developed over the past year through the activities of Steve and a Telecommunications Steering Committee from local industries. The content of the four courses, as presented by Steve, was discussed by the Advisory committee. As a result of this discussion, the title of one course was changed to allow more flexibility in the content of the course. the four courses will be entitled:

(1) Telecommunications Technologies I.
(2) Telecommunications Networks.
(3) Telecommunications Technologies II.
(4) Telecommunications Internship.

Allen Boger moved that the courses be approved by the Advisory Committee as new Electronics electives, and that they be presented to the ACC Curriculum Committee and the State Coordinating Board for approval. The motion was seconded by Nick Broline, and approved by the Committee.

Bob asked for an Electronics Advisory Committee Chairman to be named; by unanimous decision it was agreed that Allen Boger be elected to this position.

The next Advisory Committee meeting will be held in the Fall of 1991; the meeting was adjourned at 10:00 PM.

Respectfully Submitted: Katy Gott
Katy Gott, Secretary

Approved: Bob L. Bixler
Bob Bixler, ELN Department Head

ONGOING INDUSTRY LIAISON

The telecommunications industry is moving at a stunning pace. Equipment life cycles have plummeted from the 100 years enjoyed by the Strowger step-by-step switch to the 2-to-3 years of some modern equipment such as early-generation Integrated Services Digital Network interfaces.

It is essential that the curriculum and courses for telecom students keep up with this change, if our graduates are to be prepared for the job market. To that end, we have continued this year our contact with local industry representatives.

The principal means of contact this year was through the Capital Area Telecommunications Association. The ACC Telecommunications Instructor became a member of this organization and attended virtually all of the organization's meetings. Each meeting includes a presentation on some current technology or subject of interest. It is typically attended by 30 to 70 managers of telecommunications from various local government agencies, industries, and telecom equipment/service vendors. Informal discussions over coffee and breakfast have provided many useful insites into the local telecommunications industry.

The ACC Telecommunications Instructor also was able to attend the principal national convention and show of the telecom industry, SUPERCOMM 91, which was held in Houston, Texas. Seminars were attended on various aspects of the industry and visits were made to vendor booths to gather specific information on industry equipment and trends.

During the Fall of 1990, the ACC Instructor was able to attend a two-day seminar on Local Area Networks and Building Distribution Systems, hosted at a local hotel by Southwestern Bell.

As part of the first course offered this year, visits were made to two Southwestern Bell central offices in Austin, lending some additional insight into the operation of the common carrier network.

A site visit to the State Capitol Complex was made early in the grant year, following up an earlier contact with the manager of that operation. A description of the visit appears on following pages.

INDUSTRY SITE VISIT

FACILITY VISITED

Texas State Capitol Complex
Telecommunications Services Division
1706 San Jacinto
Austin, Texas 78711
Personnel Contacted: Mr. Robert Marion, Capitol Complex Installation Supervisor

VISITING PERSONNEL

Steve Kooker, Telecommunications Technology Instructor, Austin Community College

DATE

July 17, 1990

DESCRIPTION OF VISIT

This visit was the first visit to industry for the school year 1990-1991. Its purpose was to observe the telecommunications installations maintained in Austin by the Texas State Government, and to gather information about technician skills needed to work in these installations.

The visit included tours of several buildings. Mr. Marion's office building was the first stop. The only significant item of equipment in this location was a small training installation used to instruct new technicians in the mechanics of wiring and troubleshooting. It included a standard punch-down block and some associated electronics. Copies of student handouts for a 1A2 Key System course conducted by Mr. Marion, as well as a copy of a representative test for an Engineering Technician IV were obtained.

A second building visited contained a telephone switch room which serves about 4000 of the State Government's 26000 phones. The room occupies an estimated 1200 square feet. It contains an interconnect block frame, a large new digital switch in modules which occupy approximately 15 five-foot cabinets, and trunk line terminations (fiber optics). Each module of the switch contains totally redundant processors and interconnect for switching hundreds of twisted-pair phone lines onto two fiber optic trunks, which are connected to a central processing site in

another building. Cables between the switch module and the interconnect block frame are standard 25-pair cables, which terminate in the switch modules in standard connectors. These connectors can be disconnected quickly from mating connectors in the switch module. The cables run under the raised computer flooring from the switch module to the interconnect frame. Each switch module appeared to have 25 connectors for these cables.

Built-in Test will switch in the alternate processor in the event that a failure is diagnosed in the active processor of a switch module. Maintenance can then proceed by powering down the bad side, replacing the bad module, powering up and re-testing.

The interconnect blocks in this room are wire-wrap style, rather than punch-down style. Most of the wire wraps are accomplished using a simple hand tool, with a wrap anvil on one end and an unwrap hook on the other end (costs about $15). Most of the twisted pair interconnect blocks have built-in surge suppressors right on the block, with great attention paid to proper grounding of each suppressor. With proper grounding, the devices will limit voltage surges to about 100 volts; poor grounding may cause the limit to exceed 500 volts (disastrous). The surge suppression is used on all copper twisted pairs which leave this interconnect block and travel to other buildings. This represented the great majority of the lines terminating here.

All telephone wiring within each building and to the first switch is currently done with copper wiring (twisted pair). Cost is the factor which dictates this approach, even though in some buildings now being wired, it might be advantageous to use new fiber optic distribution systems, especially between floors, rather than the very heavy copper multiconductor jacketed cable.

Each section of the interconnect frame has a pigtailed multi-conductor jacketed cable wired to the back of that section. This cable runs to an overhead tray, where it is combined with cables from other sections in an aerial splice to a larger jacketed cable, which then runs to the destination building.

Large splices containing 2100 pairs can be wired together in one day, with five people working eight hours. The work is done very systematically, using fixturing which joins 25 pairs at a time. A special procedure is used to cut wires to exact length, folded in a particular fashion, and spliced; otherwise, they would not fit. Any large cable has no two wire pairs colored exactly the same; a color code distinguishes the 25 pairs within a sub-bundle from each other, and then a ribbon wrapped around each sub-bundle distinguishes the sub-bundles by color code.

Each section of the interconnect frame has test points for accessing the circuits traversing that section.

Each generation of digital switch gets smaller than the last.

The equivalent of the five-foot switch cabinets in this room are now available in a cabinet only one-third as tall.

The volume of communications which can be carried by fiber optics was dramatically illustrated by the fact that all of the telephones for the Department of Public Safety in all of Texas travel through this switch on four fibers.

They use multi-mode fiber, rather than single-mode fiber, because their runs are short enough to do so, and the cost of multi-mode fiber is much less than the cost of single-mode fiber.

A second building was visited, which contained the central processor for all the switch sites, as well as the AT&T long-distance interconnect switch, identified as a 5-ESS. The 5-ESS occupied a room of approximately 3000 square feet. This is a new installation having a value of about $12,000,000. Cross-connects are accomplished here, linking State offices across Texas, and connecting the State telecommunications network to the public common carriers. Another function carried out here is record keeping of toll traffic for billing purposes. Both analog and digital lines and trunks terminate here.

The 5-ESS system does much of the crossconnecting in software, utilizing the digital nature of most of the traffic.

Fiber is now used for interconnecting switch sites in the various buildings in the Capitol Complex, and for connecting to remote sites. Some digital microwave is used within Austin to connect the Highway Department and the Department of Public Safety.

The 5-ESS switch is owned by the State of Texas. This is a departure from past practice, when the State leased equipment.

A UNIX operating system is used on the 5-ESS. UNIX is an AT&T-developed operating system. Knowledge of UNIX would be an asset to an applicant.

The facilities run on 48 volts, supplied by a large battery bank, which in turn is charged from the AC line. In the event of a power failure, about four hours of operating current can be supplied by the batteries, after which a 46-volt cutout shuts everything down. Without the precaution of a cutout, batteries have been known to drain all the way down, necessitating a lengthy and difficult recovery procedure.

Mr. Marion is optimistic about the prospects for employment for our graduates. Many of the really skilled telecommunications personnel now working are nearing retirement age. Replacements, which once were trained in good numbers by the Bell System, are no longer so available, because of cutbacks in internal training caused by cost-competition. Poor results have been observed when graduates of local proprietary schools were hired. An Associate

Degree from ACC with a specialization in telecommunications seems very attractive.

Mr. Marion offered to help in any way possible, such as providing tours for classes.

Once an aerial splice is complete, the housing is filled with a tough waterproof gel, making water contamination impossible.

INSTRUCTOR PREPARATION

At this point in the development of ACC's Telecommunications 2+2 Program, the instructional staff for this specialization is limited to one individual. He was hired for this purpose at the inception of the program.

The activities described in the previous sections have been in large part carried out by the instructor, and certainly constitute an important part of his preparation for teaching the courses which make up the curriculum.

In addition to the activities described elsewhere, the instructor has prepared himself by extensive reading in the telecommunications field, using trade journals, textbooks, and vendor materials.

There are a large number of trade journals in the field, some of which are free to qualified readers. Three of the most general and pertinent to the curriculum we offer are Network World, PC Week, and Teleconnect.

Textbooks have been provided by publishers free of charge in most cases for evaluation. A list appeared in the Final Report for Grant Year 1989-1990. Additional textbooks have been obtained through the Learning Resource Center at ACC.

As a result of attendance at SUPERCOMM 91, the instructor is on the mailing lists of numerous vendors, and receives information on current equipment offerings which lend insight into the direction of the industry.

A collection of periodicals in the field has been made available to students in the classroom used for telecommunications classes.

RESOURCE COLLECTION

Each course offered in a technical vocational field requires some quantity of resources beyond the provision of a classroom and an instructor. Meaningful preparation of the student to enter industry includes laboratory activities involving the tools and equipment of the industry, as well as lecture content which mentally transports the student to the industrial scene. Student "ownership" of subject material typically does not occur until the theory and knowledge of lecture are used in hands-on practice.

With this in mind, the course outlines include a description of laboratory activities. In order to provide these activities, some amount of equipment and material beyond that which exists for more basic courses in electronics has been defined and supplied to ACC's administration and local industry. A list of these items appears on the following pages.

During the 1990-1991 Grant Year, a good start was made on getting some of the requisite equipment and material. Industry responded to our requests with donations of a Key Unit, Local Area Network Components, video training tapes on fiber optics, telephone switch components, and small components for lab experiments. Video tapes were purchased for the introductory course by ACC's Learning Resource Center, as well as directly from grant funds. Some laboratory material was obtained using funding through the Electronic Technology Department.

Offerings of the more advanced courses will require additional equipment such as LAN hardware and software, additional computers which are capable of running UNIX and computer-aided learning diskettes from AT&T, etc..

We expect this year to receive donations of two kinds of central office switch from one local company, for use in the Networks Course.

Resource collection is an unending activity, striving to keep abreast of the industry in our laboratory.

STUDENT RECRUITMENT

During the 1990-1991 Grant Year, we recruited students for the first telecom classes from two sources.

Most of the telecom class participants were recruited from second-year Electronics Technology Associate Degree candidates. The Introduction to Telecommunications class became one of their advanced electives. Bulletin board notices and articles about the telecom field, and contact with the Telecom Instructor in other classes, was used to attract this group of students.

The second source of students was from local industry. These students came to ACC specifically for the Introduction to Telecom course. In every case, improvement of job skills was the reason. An article in the local newspaper about the new telecom course at ACC attracted some of them, and the instructor's contact with local industry attracted others.

As time passes, we expect to receive many of our students through the 2+2 channel, where local high schools feed the program with candidates whose interest in the telecommunications field was initiated in high school. In 1989-1990, of course, the 2+2 program was too new for any of these students to have reached the level of the Introduction to Telecommunications course.

DESCRIPTION OF INITIAL COURSE OFFERINGS

Our original grant program schedule envisioned offering the first course of the telecommunications curriculum in the Fall of 1991. However, since the introductory course was identical to a course already listed in the Electronics Technology catalog (but never actually offered previously), it was decided that a first offering could be moved up to Spring, 1991.

A single section of "Introduction to Telecommunications" appeared in the class listings for registration in Spring, 1991. This section filled quickly. A second section was opened, and also filled.

The course was repeated during the summer 1991 semester with one large section being offered and filled.

During the Fall, 1991 semester, the second course in the series, "Telecommunications Networks", will be offered, as well as two sections of the "Introduction to Telecommunications".

EVALUATION OF ELECTRONICS TECHNOLOGY SUPPORT COURSES

During the 1989-1990 Grant Year, a formal report which evaluated the appropriateness and adequacy of support courses as preparation for the telecommunications specialty courses was prepared. This report appears in Appendix C.

LIAISON WITH THE HIGH SCHOOL LEVEL

As in the first year of the 2+2 telecommunications grant program, ACC coordinated its efforts with personnel from Leander High School.

Both schools were represented at the meeting of the Telecom 2+2 Steering Committee during the fall 1990 semester.

Instructors from the two schools discussed their courses and progress several times during the school year.

As time passes, additional high schools will become involved. The Bastrop, Del Valle, and Austin Independent School Districts have recently decided upon participation in 2+2 arrangements with ACC.

DEVELOPMENT OF A HOW-TO MANUAL FOR TELECOM 2+2 PROGRAMS

During the 1990-1991 grant year, information and experience gathered during ACC's development of its 2+2 Telecommunications curriculum were summarized in a document for use by other schools which are considering establishment of similar programs. This "How-To" manual is a separate document.

ACTIVITIES OF COURSE GRADUATES

One of the gratifying things about being an educator is seeing that the information taught in class is truly useful in the workplace. The current activities of several of our students reflect the usefulness of the course content of "Introduction to Telecommunications".

A current project in the Texas State Comptroller's Office is the creation of an on-line tax reporting system for businesses in Texas. A business owner or accountant will soon be able to connect the business's computer to the large computer in the State Comptroller's Office, and report the business volume, profit, tax, etc., over a telephone line, rather than using paper reporting methods. On-line prompting, menus, and help information will be available. One of our graduates is the principal software/telecom designer in the Comptroller's Office.

Another graduate is currently working for Texas Parks and Wildlife on projects to select from common carrier offerings to optimize the interconnection of Parks and Wildlife offices across the state.

A third graduate works for a local industry which is building Integrated Services Digital Network equipment. ISDN is one of the most advanced technologies in the telecommunications field.

DEVELOPMENT OF A GRADUATION FOLLOW-UP ASSESSMENT PROCESS

In addition to the informal follow-up of graduates which occurs naturally (see the preceding section), a formal method of tracking graduates has been planned. Appendix D details the plan.

APPENDIX A - LISTING OF PRINCIPAL INVESTIGATORS

(1) Stephen L. (Steve) Kooker, P.E., M.S.E.E.
Telecommunications Instructor
Electronics Department - Technology/Graphics Division
Austin Community College
P.O. Box 140646
Austin, Texas 78714
(512) 495-1627

(2) Mr. Ron Brey, Project Director
Director of Non-Traditional Instruction
Austin Community College
P.O. Box 140526
Austin, Texas 78714
(512) 483-7583

(3) Mr. Elbert Marcom
Assistant Vice President of Academic Affairs
Austin Community College
P.O. Box 140526
Austin, Texas 78714
(512) 483-7579

APPENDIX B - DETAILED COURSE OUTLINES

TELECOMMUNICATION COURSES OUTLINE
Austin Community College

ELN 2274 INTRODUCTION TO TELECOMMUNICATIONS (4-2-4) Provides a complete introduction to telephone industry history, the telephone network, local area networks, analog and digital transmission, switching, and regulation.

ELN 2284 TELECOMMUNICATIONS TECHNOLOGIES I (4-2-4). Covers Fourier representation of communications signals and systems, linear circuit theory, noise characteristics and sources, behavior of copper and optical media, modulation, filtering, amplification, phase locked loops, digital/analog interfaces, structure and protocols of modern telecommunications systems, and a survey treatment of common computer operating systems and languages found in telecommunications systems. The student who completes this course should be able to quickly identify and use technical references which allow understanding and analysis of any telecommunications equipment, and should be able to troubleshoot the equipment at a "system" level.

ELN 2294 TELECOMMUNICATIONS NETWORKS (4-2-4). Covers the historical evolution of telecommunications networks, from analog networks through modern computer-based digital networks, physical circuit switching and virtual circuit switching, digital carrier systems, switches, cross-connects, multiplexors, signalling methods, packet switching, seven-level protocol, ISDN, Signalling System 7, software operating systems including UNIX, electronic mail, voice mail, facsimile, local area networks, wide-area nets, bridges, routers, gateways, FDDI. The student who completes this course should be able to describe how voice, video, and data flow from anywhere to anywhere else, in terms of form, media, and typical rates.

ELN 2324 TELECOMMUNICATIONS TECHNOLOGIES II (4-2-4). Covers current tools and equipment of the industry, troubleshooting techniques in current use, both outside-plant and in-plant wiring practices, building distribution systems, customer interfacing, verbal and written communication, fundamentals of management including cost analysis and procurement. The student who completes this course should feel comfortable with the equipment, tools, and working environment of the telecommunications field.

ELN 2334 TELECOMMUNICATIONS INTERNSHIP (4-0-0). The student will work part-time for a local company over a period of one semester. The employment will be meaningful in terms of training for the telecommunications field. The employer will pay the student a fair market value for the work done. During the semester, the student will meet twice with an ACC telecommunications instructor, to discuss the work being done. At the end of the semester, the student will prepare a short report describing the work activity and what has been learned.

COURSE OUTLINE : INTRODUCTION TO TELECOMMUNICATIONS

TEXTBOOKS: Understanding Telephone Electronics, Howard Sams & Co., and Business Data Communications, Fitzgerald, John Wiley and Sons.

(1) Lecture: Personal introductions.
Description of Required Texts and Materials.
Description of Course Content, Schedule, and Procedures.
Description of Grading Methods.
Definition of Telecommunications, and Examples.
History of Telecommunications.

Laboratory: Students will disassemble, examine, and reassemble a basic telephone instrument.

(2) Lecture: Continue History of Telecommunications.
Describe the inside of a basic telephone.
Describe the operation of a local loop, and relate it to the operation of telephone instruments, old and new.

Laboratory: Students will disassemble a basic telephone instrument, remove the microphone and headphone transducers, connect these to a test setup which includes a power supply and oscilloscope, and explore the electrical characteristics of these transducers, using a written laboratory procedure to guide them.

(3) Lecture: Describe methods of signalling and switching in telephone networks. Describe the operation of bells, buzzers, and hybrid transformers.

Laboratory: Students will continue their investigation of the basic telephone instrument by hooking up a set of test equipment which simulates a central office power supply and ringing signal, and making observations and measurements of the telephone instrument's insides, following a laboratory procedure.

(4) Lecture: Continue a discussion about the nature of the hybrid transformer and its applications.
Sidetone adjustment for a telephone instrument will be discussed.

Laboratory: Students will set up a hybrid transformer and test equipment in an arrangement so that they may observe the coupling of microphone and headset

transducers, each having two wires, to a 2-wire phone line, through a hybrid transformer. Sidetone adjustments will be observed and explained.

(5) Lecture: The frequency response behaviour of telephones and the network of wires and equipment which connects them to each other will be discussed. In-band signalling will be discussed.

Laboratory: A lab setup will use a basic telephone, along with an audio signal transducer run from a signal generator, and an oscilloscope connected to a second, receive transducer, to investigate the frequency response behaviour of the telephone. The frequency response and attenuation of a central office loop will be measured, using a 5000-ft twisted-pair loop or a lumped-constant equivalent.

(6) Lecture: Operation of central offices will be discussed, beginning with the old step-by-step and crossbar mechanical switches and progressing to the more recent digital switches, and finally to modern, computer-based switches.

Laboratory: (Subject to availability of equipment). Four telephones will be connected to a switch, and operated, following a written laboratory procedure.

(7) Lecture: Central-office power sources will be discussed, including the large batteries typically used, their chemical makeup and behaviour, recharging, and maintenance.

Laboratory: (Subject to availability of equipment). Each group of 3 to 4 students will examine a typical 2-volt storage battery, read the manufacturer's descriptive literature, and perform a written laboratory procedure to measure specific gravity, observe a short charge cycle, and measure the cell's electrical characteristics.

(8) Field Trip: The class will visit a typical Central Office, either at a Southwestern Bell facility, or at one of the large local companies which maintain their own switch.

(9) Lecture: Channel banks will be discussed. Space-division switching will be reviewed and discussed more thoroughly, in all its historical forms. A brief introduction of analog-to-digital conversion and its impact on the design of switching systems will conclude this lecture.

Laboratory: First Examination.

(10) Lecture: Analog-to-digital and digital-to-analog conversion will be discussed.
Laboratory: Each student will assemble a circuit which has in it an analog source from a power supply, an analog-to-digital converter, and a means for observing the digital output word. A written laboratory procedure will guide an exploration into the behaviour of A/D converters.

(11) Lecture: Continuation of the discussion of A/D and D/A conversion.

Laboratory: Each student will add to his lab setup from the previous period a D/A converter, and investigate its behaviour. The A/D converter from the previous lab will be connected back-to-back to the D/A converter, and the end-to-end effect of conversion/reconversion will be observed.

(12) Lecture: Discussion of digital data transmission of analog phone conversations.

Laboratory: Each lab group will add a transmit transducer and a receive transducer to its A/D and D/A setup, along with the necessary interfacing circuitry. Pairs of lab groups will then combine their setups to form combination full-duplex setups, and demonstrate a telephone conversation transmitted by means of digital data, following a written lab procedure.

(13) Lecture: Discussion of different methods of transmitting digital data, the kinds of errors which may occur and how these affect speech transmission, how to detect and correct errors in digital transmission.

Laboratory: Students will explore Time-Division Multiplexing by combining two digital data streams of known composition, then separating them and recovering each one, using a written laboratory procedure.

(14) Lecture: Discussion of digital phones and channel banks.

Laboratory: Examination 2.

(15) Lecture: Discussion of cellular phones and mobile phones, and the switching centers used with them.

Laboratory: A cellular phone and a mobile phone will be used to make and receive calls. A cellular phone will be disassembled to examine its working parts,

then reassembled.

(16) Field Trip: The class will tour one of the two local switching sites for cellular telephones.

(17) Lecture: Discussion of transmission media, including open wire, twisted pair, coax, and fiber-optic cables.

(18) Laboratory: Students will observe the characteristics of twisted-pair cables, by transmitting signals of different frequencies and pulse shapes through long runs of twisted-pair cables.

(19) Lecture: Continue discussion of transmission media.

Laboratory: Students will observe the characteristics of coax cables, by transmitting signals of different frequencies and pulse shapes through long runs of twisted-pair cables.

(20) Lecture: Continue discussion of transmission media.

Laboratory: Students will perform an experiment using optical fibers, observing the behaviour of fibers of two different types, and investigating the behaviour of splices.

(21) Lecture: Discussion of how telephone and data signals are transmitted in broadband form, using various kinds of modulation.

Laboratory: Students will set up an experiment which demonstrates amplitude modulation and frequency modulation.

(22) Lecture: Continue discussion of modulation techniques.

Laboratory: Students will set up an experiment which demonstrates phase modulation.

(23) Lecture: Continue discussion of modulation techniques.

Laboratory: Students will build a circuit which modulates three baseband telephone signals onto a carrier frequency, and the resulting signal will be observed using test equipment.

(24) Lecture: Discussion of demodulation circuitry.

Laboratory: Students will add to the previous lab setup a circuit which demodulates the carrier and recovers the three baseband telephone signals.

(25) Lecture: Discussion of common equipment used to send

data over standard telephone lines (modems).

Laboratory: Students will use two computers, two modems, and two telephone lines to send data from one computer to another.

(26) Lecture: Discussion of computer networks, including computer bulletin boards for personal computer users, and the personal computer software packages used to access remote computers.

Laboratory: Students will use a personal computer and associated modem and software to access a bulletin board service and download a software package to their computer.

(27) Lecture: Discussion of Local Area Networks.

Laboratory: Students will perform an experiment which demonstrates the Appletalk LAN linking the MacIntosh computers in a computer lab.

(28) Lecture: Continue discussion of LANs, with emphasis on popular architectures such as the Novell LAN software and associated hardware.

(29) Laboratory: Students will link three IBM Personal using LAN hardware and software kits provided.

(30) Open

(31) Open

(32) Final Examination.

COURSE OUTLINE : TELECOMMUNICATIONS TECHNOLOGIES

TEXTBOOK: Modern Electronic Communication, Miller, Prentice-Hall.

(1) Lecture: Personal Introductions.
Description of Required Texts and Materials.
Description of Course Content, Schedule, and Procedures.
Description of Grading Methods.
Survey of the Telecommunications-related technologies to be covered.

(2) Lecture: A review of electronics fundamentals, ranging from a discussion of the Fourier analysis of signals through a discussion of noise and the properties of the basic circuit elements.

Laboratory: Students will empirically determine the behaviour of a basic RLC circuit (given) at a number of different frequencies, and relate this to the frequency spectrum assigned to various communications users, such as radio, TV, cellular telephone, microwave!, etc..

(3) Lecture: Sources of noise in electrical communication circuits will be discussed, first in general terms with relation to the problems caused by noise, then in analytical terms related to the properties of materials.

Laboratory: Students will build a multi-stage high-gain amplifier whose input is simply a termination impedance, and examine the noise present at several different points in the amplifier. A diode may be substituted for the input impedance, or resistors of different types may be tried.

(4) Lecture: Attenuation and crosstalk in electrical communication circuits will be discussed, for different forms of conductive wire transmission.

Laboratory: The behaviour of open-wire, twisted-pair, and coax will be empirically determined using sine wave and pulse generators, lengths of each wire, and oscilloscopes. Inductive signal loops connected to a second signal source will be used to test each wire type for susceptibility to induced noise.

(5) Lecture: Attenuation of pulse signals transmitted down a twisted-pair telephone cable will be examined analytically. The effect of loading coils will be analyzed.

Laboratory: Students will set up a pulse source and connect it to long wire loops of several thousand feet, and observe the output at the other end. This will be repeated with loading coils inserted between long loops.

(6) Lecture: Electronic circuitry designed to overcome induced signals and attenuation will be discussed.

Laboratory: Students will transmit a pulse signal down a long twisted-pair, first using a single-ended transmitter and receiver (pulse generator and an oscilloscope), and then will repeat the experiment after inserting a balanced transmitter integrated circuit and a balanced receiver integrated circuit inserted at the two wire ends.

(7) Lecture: The behaviour of optical fibers will be discussed, and their behaviour in the presence of electrical interference sources will be pointed out.

Laboratory: Students will use optical fibers, optical transmitters , and optical receivers to observe their ability to transmit a pulse signal.

(8) Lecture: Continue discussion of optical fibers.

Laboratory: Students will examine the effect of fiber length and splices, and compare single-mode to multi-mode fibers.

(9) Field Trip: Students will visit a local industry which is involved in production of fiber optic components.

(10) Examination 1.

(11) Lecture: Discussion of Amplitude Modulation.

Laboratory: Students will build a simple amplitude modulator, and use it to modulate a 20 kHz signal onto a 1 mHz carrier.

(12) Lecture: Discussion of Amplitude Demodulation.

(13) Laboratory: Students will add a simple demodulator to their setup of the previous lab, and observe its operation. Behaviour of the modulation/demodulation as the frequencies of carrier and modulation are varied will be observed.

(14) Lecture: Discussion of bandwidth requirement reduction by means of single-sideband transmission.

Laboratory: Students will add a sideband-elimination filter between the modulator and demodulator of their lab setup, and observed the result.

(15) Lecture: Crystal filters and mechanical filters will be discussed as an alternative to RLC filters.

Laboratory: The RLC filter used in the previous lab will be replaced by a crystal filter and then by a mechanical filter, and the results will be observed. (Subject to availability of material).

(16) Lecture: Transmission of multiple signals on one broadband signal will be discussed.

Laboratory: A circuit will be assembled which allows three different audio signals to be modulated onto carrier frequencies spaced 40 kHz apart. The composite signal will be transmitted down a 100-ft twisted-pair cable. Another circuit will then recover and separate the three audio signals.

(17) Continuation of laboratory for Session (16).

(18) Open.

(19) Examination 2.

(20) Lecture: Frequency modulation will be discussed.

Laboratory: A simple frequency modulator will be assembled and observed, modulating a 20 kHz signal onto a 1 mHz carrier.

(21) Lecture: Frequency demodulation will be discussed.

Laboratory: A simple frequency demodulator will be discussed.

(22) Lecture: Continue discussion of frequency modulation.

Laboratory: The interference-rejection qualities of FM transmission will be demonstrated.

(23) Lecture: Various refinements of FM transmission, such as improved modulators, stereo techniques, etc., will be discussed.

Laboratory: An integrated-circuit linear voltage-controlled oscillator will be used to build another type of frequency modulator.

(24) Lecture: Phase locked loops will be discussed, with an emphasis on their use as FM demodulators.

Laboratory: A phase-locked loop demodulator will be built and used in combination with the previous lab's setup to demonstrate transmission of an audio signal by means of FM.

(25) Field Trip: A local transmitter for mobile radios will be visited.

(26) Lecture: A survey of how voice and data is transmitted from place to place, by means of various media and modulation techniques.

(27) Lecture: A discussion of pulse code modulation, and the structure and protocols of our modern telecom system.

(28) Lecture: Description of computer operating systems and languages, and a survey of the most common ones. Discussion of software designed to implement communication between computers.

(29) Lecture: Discussion of common carriers and their media, including fiber optics, microwave, and satellites.

(30) Lecture: Discussion of cellular and mobile phones, and the proposed satellite phone system.

(31) Open.

(32) Final Examination.

COURSE OUTLINE : TELECOMMUNICATIONS NETWORKS

TEXTBOOK: ISDN, AN INTRODUCTION, William Stallings, MacMillan Publishing Company.

LIBRARY RESERVE TEXTBOOKS: Business Data Communications, 2nd Edition, David A. Stamper, The Benjamin/Cummins Publishing Company, Inc., and Understanding Telephone Electronics, Howard Sams and Company.

(1) Lecture: Personal Introductions.
Description of Required Texts and Materials.
Description of Course Content, Schedule, and Procedures.
Description of Grading Methods.
Survey of the various types of telecommunications networks to be covered.

(2) Lecture: Discussion of the evolution of telecommunications from the first analog-type telephones and manual switchboards to the present communications culture where digital technology is becoming predominant.

(3) Lecture: Survey of the means by which voice and data have been digitized, switched, and transmitted. The impact of the computer revolution on telecommunications requirements and system implementations.

(4) Lecture: Discussion of circuit switching and packet switching. In-depth discussion of circuit switching. Physical circuit switching and Virtual Circuit switching.

(5) Lecture: Discussion of digital carrier systems, as they have evolved over the past few decades. Switches, cross-connects, multiplexors.

(6) Lecture: Industry standards for telecommunications networks.

(7) Lecture: The influence and control of government in the telecommunications arena: historical revue and current status and trends.

Writing Assignment 1 Due: A paper summarizing the first six lectures and reading assignments is due.

(8) Field Trip: The class will visit a large telecommunications switch site which handles voice and data for the State of Texas.

(9) Lecture: A discussion of different call routing schemes which

have been used. Trends, and the effect of new technology on current and future routing techniques.

(10) Lecture: Signalling, from the methods of our analog past to the digital networks of today. In-channel, Common-Channel.

(11) Lecture: Packet Switching. Discussion of different kinds of data. Virtual circuits and datagrams. Comparison of circuit switching and packet switching.

(12) Lecture: Routing methods for packet switched networks. Congestion control. The X.25 Standard.

(13) Lecture: Discussion of the seven-level architecture of modern telecommunications networks, which forms the basis for many of the standards currently in use.

(14) Lecture: The evolution of the Integrated Digital Network. Features, advantages and disadvantages of digital networks. Digital subscriber loops, multiplexers, echo cancellation. CCIT Signalling System Number 7.

(15) Lecture: The mechanics of digitizing analog voice: Analog to Digital Conversion, Digital to Analog Conversion, different standards for amplitude compression.

Writing Assignment 2 Due: A summary of the seventh through fourteenth lectures and assignments is due.

(16) Lecture: Discussion of computer software. The difference between an operating system and a language compiler or an applications program. What software is used in telecommunications equipment, and what various kinds of software do there.

(17) Lecture: Discussion of operating systems. How UNIX, the operating system used in a number of telecom systems, differs from DOS, the familiar operating system for the IBM Personal Computer.

(18) Lecture: An in-depth introduction to UNIX.

Laboratory: Students will experiment with UNIX by performing a lab exercise using an IBM/386-class machine with a UNIX operating system.

(19) Laboratory: Students will continue their structured lab exercise using the UNIX Operating System.

(20) Lecture: A discussion of how to load and set up a UNIX

Operating Environment on an IBM/386 class machine, including how to assume the role of System Manager.

(21) Field Trip: The class will visit a local cellular switch site, where the main switch is a UNIX-based machine, and the technicians who run the site use troubleshooting methods based on having a UNIX environment.

Writing Assignment 3 is Due: A summary of Lectures fifteen through 20.

(22) Lecture: Principles of the Integrated Services Digital Network will be discussed. How ISDN supports the transmission of voice, data, and video on the same network, taking advantage of modern bandwidth capabilities of such technologies as fiber optics.

(23) Lecture: Electronic Mail, Voice Mail, Facsimile, as integrated into ISDN.

(24) Lecture: Local Area Networks, an introduction and a historical survey. Bus, star, and ring topologies. Current trends.

(25) Lecture: The integration of multiple LANS via telecom networks. Wide-area nets, Metropolitan-area nets. Bridges and Gateways. The seven-level standards.

(26) Lecture: Troubleshooting LANS. The Lanalyzer, and other tools of the trade. Coax and twisted pair. Fiber optics.

(27) Lecture: The Fiber Distributed Data Interface (FDDI). What it is, what it means to LAN users, how it will be maintained.

(28) Lecture: ISDN: the standard and its transmission structure. Addressing and protocols. Signalling.

(29) Lecture: International ISDN: The opportunities and the problems.

(30) Lecture: Review and Summary of Telecommunications Networks.

(31) Open

(32) Final Examination.

COURSE OUTLINE : TELECOMMUNICATIONS PRACTICE

TEXTBOOKS: No single suitable textbook has been discovered which is appropriate for this course. A number of manuals which cover specialized subjects in this area will be put on reserve in the ACC Library. For example, the series of books published under the title ABC'S OF TELEPHONY, published by ABC Teletraining, Inc., of Geneva, Illinois, will be available.

As the course evolves, it is possible that a looseleaf manual may be developed, with sections written by the instructor or by local industry personnel, covering tools and practice as they are used in local industry.

(OUTLINE TO BE DETERMINED, INDUSTRY SUGGESTIONS SOLICITED)

Our intent for this course is that the lectures will explore in detail the environment that a telecommunications technician typically works in, by describing the equipment he works on, the tools which he uses (from hand tools to simple test items to commercial test equipment like LANalyzers and reflectometers), the various types of media (wire, fiber, microwaves) , the history and characteristics of each medium and how to troubleshoot it, how installations and changes are done, how to interface with customers, etc..

Field trips are expected to be an important part of this course. Five field trips, to locations where major new installations or renovations are underway, are planned.

Guest lectures will also be solicited, inviting technicians who are already working in the field to come to the classroom and describe some of the tools and techniques which are used in their particular job.

COURSE OUTLINE : TELECOMMUNICATIONS INTERNSHIP

(Strawman Version, November, 1990)

(1) Student will work part-time for a local company over a period of one semester. The employment will be understood to be temporary. The employer will pay the student a fair wage for the work done. In the current job market environment, this should range from $6 to $9 per hour, depending on the student's background.

(2) At least 100 hours of working time will be completed.

(3) The employer will provide work which is meaningful in terms of training for telecommunications.

(4) The student will meet twice during the semester with his ACC telecommunications instructor, to discuss the work being done. At the end of the semester, the student will prepare a short report describing his work activity and what he has learned.

(5) The employer may terminate the arrangement at any time for reasonable cause. Under these circumstances, the student will receive a withdrawal, incomplete, or failing grade, at the prerogative of the ACC telecom instructor.

(6) Students will otherwise receive a letter grade based on a verbal report from the employer, their conferences with the ACC telecom instructor, and their final report.

APPENDIX C - SUPPORT COURSE EVALUATION REPORT

CURRICULUM EVALUATION REPORT FOR THE TELECOMMUNICATIONS TECHNOLOGY 2+2 PROGRAM

December 17, 1990

Submitted by the

ELECTRONICS DEPARTMENT
of the
TECHNOLOGY/GRAPHICS DIVISION

Prepared by

Steve Kooker
Instructor of Telecommunications Technology

AUSTIN COMMUNITY COLLEGE
P.O. Box 140646
Austin, Texas 78714

TABLE OF CONTENTS

SECTION TITLE	Page
EXECUTIVE SUMMARY	1
SUMMARY OF COMPETENCIES FOR TECHNICAN GRADUATES	2
THE POST-SECONDARY TELECOM 2+2 CURRICULUM PLAN	4
CURRICULUM EVALUATION BY INDIVIDUAL COURSE	6
RECOMMENDATIONS	9

EXECUTIVE SUMMARY

This report presents an evaluation of related technology program courses at Austin Community College, with respect to their suitability for support of the Telecommunications 2+2 Program.

We begin by reviewing the summarized results of our industry survey and DACUM process.

Next, the curriculum plan devised in the past year to meet the needs of industry for telecommunications technicians is reviewed.

With this base of information, the support courses in the curriculum plan are then examined individually for suitability.

Last, recommendations are made for changes as appropriate.

SUMMARY OF COMPETENCIES FOR TECHNICIAN GRADUATES

As the information-gathering phase of the Telecommunications 2+2 Curriculum Development effort proceeded during the 1989-1990 year, the essential technical elements of the curriculum for an Associate Degree Plan were determined, as expected. Somewhat unexpected was the emphasis which prospective telecommunications employers placed on some non-technical attributes desired in new techician hires.

On the following page, a Summary of Competencies is presented. This summary was a part of the Project Report for 1989/1990. It is a concise representation of both the industry surveys and the DACUM process. What is evident is that certain technical skills are desired, and that certain non-technical skills are also an essential part of a technician's capabilities.

The stated purpose of this report, as listed in the goals for the Telecommunications 2+2 Program Grant Application, was to examine the appropriateness of "related technology programs" at ACC as they support the Telecommunications 2+2 Curriculum. We will expand that definition somewhat in this report, to discuss also some non-technical support courses which appear in the Telecommunications 2+2 Curriculum.

Summary of Competencies

The characteristics of the graduating student who has the most opportunity for finding a good job in the telecommunications industry in our area are:

(1) An Associate Degree from a public, accredited institution.

(2) A strong background in all the basic areas of electronic theory, including analog and digital circuit operation, microprocessors, radio-frequency theory and practice, telephone systems basics, communications networks and systems design standards, computer software including UNIX operating system usage, and selection and usage of test equipment used in the telecommunications field.

(3) A demonstrated facility with the English language and the basics of communication, both written and spoken. The ability to read instruction manuals, industry publications, and company communications, and then to apply the information independently is crucial.

(4) Interpersonal skills which allow successful interfacing with the public and coworkers.

(5) Managerial skills which allow the technician to be a self-starter, and give him the ability to organize his own efforts and the tasks for which he is responsible.

THE POST-SECONDARY TELECOM 2+2 CURRICULUM PLAN

The following page outlines the Post-Secondary Telecommunications 2+2 Curriculum Plan, as it is presently proposed.

Much of this curriculum plan is the same as the existing plans for other specializations in the Electronics Department. It differs only in that five courses at the "top" of the plan are specifically aimed at preparing students for telecommunications industry jobs.

Twelve courses in the curriculum plan are not special to the Telecommunications 2+2 Associate Degree, and these are the courses which will be addressed in the following section for their appropriateness as support courses for the Telecom curriculum.

NITY COLLEGE TELECOMMUNICATIONS TECHNOLOGY 2+2 PROJECT

ELECTRONIC TECHNOLOGY DEGREE PLAN : TELECOMMUNICATIONS OPTION
FOR 2+2 PARTICIPANTS

SEMESTER I			CREDIT HOURS
MTH	1743	College Algebra	3
ELN	2094	Basic Digital Logic	4
ENG	1613	English Composition I	3
GOV	2623	Texas Government	3
ELN	2114	Microprocessors I	4
SEMESTER II			
ELN	2134	Electronics Mathematics	4
ELN	2084	Pulse Digital Electronics	4
PHY	1614	General College Physics I	4
ELN	2274	Introduction to Telecommunications	4
SEMESTER III			
TCM	1603	Introduction to Technical Writing	3
ELN	2104	Advanced Linear Circuits	4
ELN	2214	Microprocessors II	4
ELN	XXXX	Telecommunications Technologies	4
XXX	XXXX	General Elective	3
SEMESTER IV			
ELN	2074	Project Fabrication	4
ELN	XXXX	Telecommunications Networks	4
ELN	XXXX	Telecommunications Practice	4
ELN	XXXX	Electronics Elective **	4
TOTAL			67

** APPROVED ELECTRONICS ELECTIVES

ELN	WWWW	Telecommunications Internship
ELN	2244	Modern Communications
ELN	2204	Computer Repair
ELN	2254	Electronic Test/TS
ELN	2264	Microprocessors III

CURRICULUM EVALUATION BY INDIVIDUAL COURSE

(1) MTH 1743 College Algebra - This course prepares the student for the kinds of algebraic equation manipulation which is necessary for solving electronic circuit problems. The concept of complex numbers, which is necessary to solve circuit problems for phase angle of current and voltage, is covered in this course. Exponential functions, which occur in the study of pulse transmission, is taught. Many circuit problems require solution of a system of simultaneous equations, and that is taught in this course. Experience of the Electronics Staff is that students who master College Algebra are well prepared for electronics courses. No reason is apparent for making changes.

(2) ELN 2094 Basic Digital Logic - Basic concepts for circuits whose signal points typically have two states are taught. The student learns how sets of such signal points can be made to represent binary numbers, which can then be manipulated by logical and arithmetic circuits to perform useful functions. These concepts are necessary for understanding how digital computers and other digital processors work. Since the digital computer is an integral part of telecommunications systems, this course is important as preparation for the telecommunications technician. No reason for changing this course presents itself.

(3) ENG 1613 English Composition I - This course is intended to give the student practice in effective composition of written communications. This is an absolutely essential skill for employability in the telecommunications field today, as our industry surveys show. The experience of the Electronics Staff is that many students are not adequately prepared in speaking and writing, even after having had this course. No doubt the problem does not lie in this single course; all students have had an extensive background (hopefully) in English during their earlier school years. Having said that, there may still be room for improvement in English Composition I. The courses to be offered in Telecommunications will have elements which are designed to enhance the student's ability to communicate effectively.

(4) GOV 2623 Texas Government - This study of state and local government gives the student an understanding of how the political process and regulatory process works. This is useful in later understanding of such regulations as telephone tariffs. No apparent need for change is evident in this course.

(5) ELN 2114 Microprocessors I - In this course, the student is first introduced to how a computer works at the assembly language level, that is, what the individual steps of arithmetic and logical processing are and how to combine them to accomplish manipulation of digital data. This is crucial to understanding

in later telecommunications courses how data streams can be

manipulated in "real time" by a computer, to perform such functions as software switching of telephone data circuits. The processor studied is the Motorola 68XXX, which forms the basis for many commercial computer systems used in the telephone industry. This is an excellent course, taught with an individual computer for each student in the class. No changes are desirable.

(6) ELN 2134 Electronics Mathematics - Programming a computer in a higher-order language (BASIC) is introduced to the student in the first half of this course, which enlightens the student about the power of higher-order languages for making repetitive arithmetic and logical analyses practical in the solution of everyday problems. Then in the second half of the course, the student's programming skills are combined with the introduction of algorithms and standard methods of analysis like determinants, to perform solutions of electronic circuit problems. An example is to analyze and graph the response of a linear circuit such as a transmission line to a pulse input such as might be found in a telephone system. This is an excellent course, and no changes are desirable.

(7) ELN 2084 Pulse Digital Electronics - In this course, the student learns to represent electronic signals mathematically as either exponential functions or as orthogonal transcendental series. Examples of pulse functions such as square waves are analyzed using one of the mathematical representations. Each pulse function is applied to a linear circuit, and the output is calculated. Then a lab exercise is performed to verify the analysis. The student who masters this course is prepared to analyze the performance of linear transmission media such as those found in telephone systems, predicting the pulse attenuation and shaping caused by the amplitude and phase response of the media. He will also understand the theory of compensation networks, and appreciate the advantages of digital representation and transmission of analog signals. No changes are desirable in this course.

(8) PHY 1614 General College Physics I - Students learn in this course how to apply mathematical descriptions to various natural phenomena, such as heat, light, force and mass, sound, and so forth. This is good preparation for appreciating the use of mathematics to describe electronic processes. No useful change to this course is evident, to prepare the student for telecommunications.

(9) TCM 1603 Introduction to Technical Writing - This course gives students some tools to use, and some practice, in the presentation of their ideas to others. The ability to write and speak effectively will open many doors to our graduates in telecommunications; in fact, most employers are not interested in hiring someone who is ineffective in this area.

7

The observation of the Electronics Staff is that this course is effectively taught, but that many students simply cannot

make enough progress during the course to be considered adequate; they have begun the college experience with a woefully inadequate capability. Many of the students who have problems in this area are foreign nationals (many of whom attend ACC because they cannot qualify scholastically or economically elsewhere), and others are from secondary school environments where they were not adequately prepared. No useful changes to the existing course are known, but it is possible that first-year students should be more carefully screened to enroll them in additional remedial work in the English/Writing disciplines prior to this course.

(10) ELN 2104 Advanced Linear Circuits - Students gain experience in this course with various elements of linear circuits, including transistors, operational amplifiers, RLC networks, etc.. Small-signal models for analyzing amplifiers and other functions are studied. These electronic building blocks will be encountered again in telecommunications courses, where they are found in such equipment as telephone channel banks, amplifiers, and compensation networks. Lab exercises are used to verify analyses, reinforcing the lessons learned. No useful change is evident for this course.

(11) ELN 2214 Microprocessors II - In this course, students are introduced to the second of the two dominant processors in industry today, the INTEL 80XXX series, as used in the IBM Personal Computer and the millions of compatible machines. The course is similar to Microprocessors I, in that assembly language programming is used to gain a mastery of the bit-level operation of this family of processors. Further practice in creating useful programs at the assembly-language level is attained. Familiarity with this processor is important to the telecommunications technician, because he must be able to troubleshoot networks of IBM-compatible computers. To do this effectively, an understanding of the computer hardware and software is essential. Later courses in telecommunications build on the knowledge attained in this course. No useful change to the course is apparent.

(12) ELN 2074 Project Fabrication - The student in this course picks a project and executes it, under the individual supervision of the instructor. The project must consist of assembly and test of some electronic function. Skills learned include soldering, breadboarding, parts procurement, etc.. These skills will be useful to the telecommunications technician in most cases. No useful change to this course is evident.

RECOMMENDATIONS

(1) In the area of technical support courses for telecommunications, taught in the Electronics, Mathematics, and Physics Departments, there seems to be no reason to alter the courses as described in the preceding section. All of the courses address the subject matter in an effective way. This is no doubt due to the fact that the courses have been taught for some time. Also, although telecommunications is a field of specialization, the theoretical basis for the industry has much in common with many other fields of specialization which came before it.

(2) In the area of non-technical support courses such as English and Technical Writing, we have two recommendations:

(a) Entering students should be more carefully screened for ability, and more of them should be required to complete remedial courses before entering the courses specifically discussed here, so that their ability level is higher when they enter the advanced telecommunications courses.

(b) The telecommunications courses taught in the Electronics Department must incorporate practice in written and spoken communications.

APPENDIX D - ASSESSMENT PROCESS DESCRIPTION

TELECOMMUNICATIONS TECHNOLOGY TECH-PREP EVALUATION PROCESS

Leander Independent School District and

Austin Community College

FORMS:

Leander Independent School District

A. Student Course Evaluation Form: Each student in a Principles of Technology, Electronics or Telecommunications or other course in the Tech-Prep sequence will evaluate the course. This is done each semester the course is offered.

B. Instructor Course Evaluation Form: The instructor of each course in the Tech-Prep series will conduct a course evaluation each time the course is offered.

C. Non-continuation Form for Student Not Following Graduation Plan: Information will be obtained from students who has a Tech-Prep graduation plan but then deviates from that plan. This form will be given to students the semester after they deviate from their plan.

Austin Community College

A. Evaluation Form for Course in Degree Plan: This evaluation occurs at least once each year for each course taught by an instructor.

B. Determine Educational Goals at ACC and Basic Information About Student: This will be given each student when he/she takes their first course in Telecommunications Technology.

C. Non-continuation in Program Form: Each student will be contacted whenever he/she does not continue taking courses in the Telecommunications Technology program and the information in form ACC-B indicates that they originally were going beyond this point. For example, a student who indicated that he/she was going to take only the one course would not be contacted.

D. Short-term Evaluation of Program Six Months After Graduation/Certificate Form: This will obtain information about how successful students are in obtaining jobs and meeting their career goals.

E. Long-term Evaluation of Program Form: Two years after leaving the program a form very similar to D will be sent to ex-students.

F. Employer Evaluation of Student Form: This form will be sent to an ex-students employer after receiving back either form D or E.

FLOW CHART FOR EVALUATING TECH-PREP STUDENTS